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UNITED STATES AIR FORCE
IERA

JP-8 Volatility Study

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13. ABSTRACT *(Maximum 200 words)*

The Clean Air Act and related State/local regulations require facilities to periodically prepare and submit air emissions inventories which quantify the annual emissions from the various stationary sources/processes located at the installation. For Air Force installations, these inventories must include the evaporative losses associated with the transfer and storage of jet fuel (i.e., JP-8). To accurately calculate the evaporative losses associated with fuel storage and transfer operation, the true vapor pressure of the fuel at various "ambient" temperatures must be known. Unfortunately, very little JP-8 vapor pressure information is currently available for temperatures at or below 100 degrees Fahrenheit. This report measured the true vapor pressure of several representative JP-8 fuel at seven different ambient range temperatures.

14. SUBJECT TERMS
Air Emissions Inventory, Volatile Organic Compounds (VOC), JP-8, evaporative losses, vapor pressure, jet fuel, ASTM D 93, ASTM D 5191, ASTM D 2887

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1.0 BACKGROUND/SCOPE

The Clean Air Act and related State/local regulations require facilities (including Air Force installations) to periodically prepare and submit air emissions inventories which quantify the annual emissions from the various stationary sources/processes located at the installation. For Air Force installations, these inventories must include the evaporative losses associated with the storage and transfer of jet fuel (i.e., JP-8). To accurately calculate the evaporative losses associated with fuel storage and transfer operations, the true vapor pressure of the fuel at various "ambient" temperatures (ranging from 40-100°F) must be known. Unfortunately, very little JP-8 vapor pressure information is currently available for temperatures at or below 100°F. The purpose of this effort is to measure the true vapor pressure of several representative JP-8 fuel samples at seven different ambient-range temperatures.

2.0 APPLICABLE DOCUMENTS

1. Military Specification MIL-T-83133D, "Turbine Fuel, Aviation, Kerosene Types, NATO F-34 (JP-8) and NATO F-35," 29 January 1992.
2. Coordinating Research Council (CRC) Aviation Fuel Properties Handbook
3. American Society for Testing and Materials (ASTM) Test Method D5191-96, "Standard Test Method for Vapor Pressure of Petroleum Products (Mini Method)"
4. ASTM Test Method D5842-95, "Standard Practice for Sampling and Handling of Fuels for Volatility Measurement"
5. ASTM Test Method D93, "Standard Test Methods for Flash Point by Pensky-Martens Closed Cup Testers"
6. ASTM Test Method D2887, "Boiling Range Distribution of Petroleum Fractions by GC"
7. Documents found on the Air Force Research Laboratory's Fuels Branch (AFRL/PRSF) internet site: https://posfbbs.appl.wpafb.af.mil/

3.0 APPROACH

Under this project, SwRI obtained and analyzed six different samples of JP-8. The samples were selected based on their flash point as measured by ASTM D 93. Samples were selected to cover the range from 38° to 60°C (100° to 140°F) to the extent possible. The Air Force also requested that samples be obtained from as many of the Defense Energy Regions as possible. The Defense Energy Regions are shown in Figure 1.

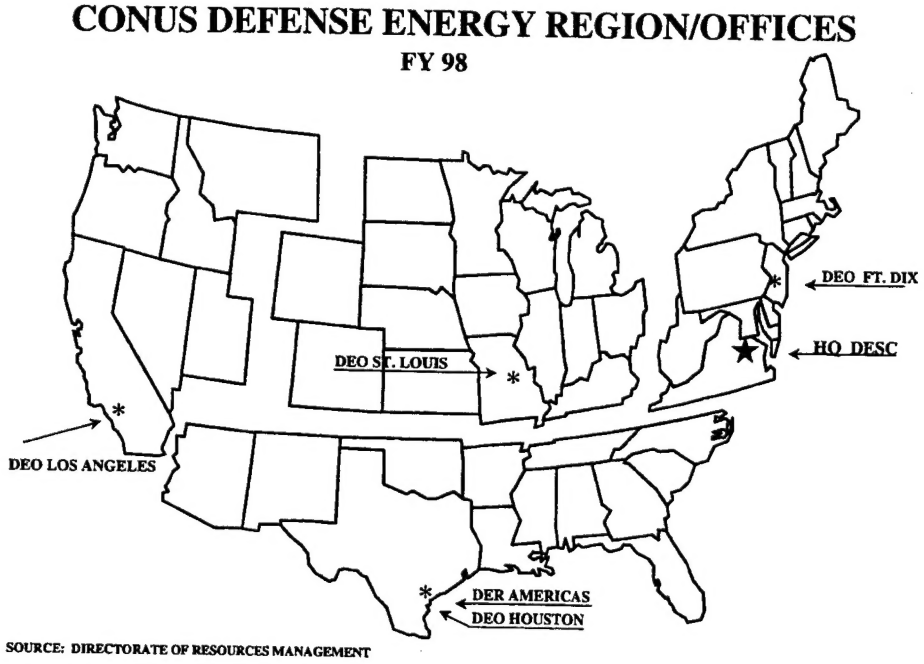


Figure 1. Defense Energy Regions

SwRI obtained fuel delivery data from the Defense Energy Support Center headquarters. Using this information, SwRI selected candidate fuel sample sites and submitted the list to the technical project manager. Following approval, SwRI arranged to obtain the selected samples.

SwRI provided sampling instructions and sample containers. The sampling instructions were written in accordance with standardized sampling methods currently available from ASTM and the Air Force. The sample containers were 1-gallon, epoxy-lined, steel cans.

The following analyses were performed on each.

3.1 Standard Test Method for Flash-Point by Pensky-Martens Closed Cup Tester, ASTM D 93.

Under this test method, a brass test cup of specified dimensions, filled to the inside mark with test specimen and fitted with a cover of specified dimensions, is heated and the specimen stirred at specified rates, by either of two defined procedures (A or B). An ignition source is directed into the test cup at regular intervals with simultaneous interruption of the stirring, until a flash is detected.

3.2 Vapor Pressure by the Mini-Method, ASTM D 5191, at four temperatures.

Under this test method, a known volume of chilled, air-saturated sample is introduced into an evacuated, thermostatically controlled test chamber, the internal volume of which is five times that of the total test specimen introduced into the chamber. After injection into the test chamber, the test specimen is allowed to reach thermal equilibrium at the test temperature. The resulting rise in pressure in the chamber is measured using a pressure transducer sensor and indicator. Only total pressure measurements (sum of the partial pressure of the sample and the partial pressure of the dissolved air) are used in this test method, although some instruments can measure the absolute pressure of the sample as well.

This test method covers the use of automated vapor pressure instruments to determine the total vapor pressure exerted in vacuum by air-containing, volatile, liquid petroleum products. This test method is suitable for testing samples with boiling points above 0°C (32°F) that exert a vapor pressure between 7 and 130 kPa (1.0 and 18.6 psi) at 37.8°C (100°F) at a vapor-to-liquid ratio of 4:1. Measurements are made on liquid sample sizes in the range from 1 to 10 mL. No account is

made for dissolved water in the sample. Although the method is not specifically applicable to JP-8 fuels, it is the method most commonly used to measure vapor pressure. The tests were conducted to provide comparison data with the results from the gas chromatography method. The selected test temperatures were 40°F, 60°F, 80°F, and 100°F. Four different temperatures were selected because vapor pressure is a function of temperature. These temperatures were selected to cover a reasonable range of typical ambient temperatures for fuel storage.

3.3 Standard Test Method for Boiling Range Distribution of Petroleum Fractions by Gas Chromatography, ASTM D 2887.

The boiling range distribution determination by distillation is simulated by the use of gas chromatography. A non-polar packed or open tubular (capillary) gas chromatographic column is used to elute the hydrocarbon components of the sample in order of increasing boiling point. The column temperature is raised at a reproducible linear rate and the area under the chromatogram is recorded throughout the analysis. Boiling points are assigned to the time axis from a calibration curve obtained under the same chromatographic conditions by analyzing a known mixture of hydrocarbons covering the boiling range expected in the sample. From these data, the boiling range distribution can be obtained.

3.4 Vapor Pressure and Vapor Speciation by Gas Chromatography at 40°F, 50°F, 60°F, 70°F, 80°F, 90°F, and 100°F. The speciation included special attention to compounds listed as Hazardous Air Pollutants.

To summarize this method, the fuel sample is heated to the desired temperature in a fuel vaporization chamber. A sample of the vapor space is collected and injected into a gas chromatograph (GC). In the GC, the various compounds present in the vapor are separated. Data analysis software is used to identify (speciate) each peak, normalize the peak areas, and calculate the molar concentration of each compound. The individual molar concentrations are then summed to obtain the total molar concentration of hydrocarbons in the vapor. That number is then used to calculate the vapor pressure as described later in this report.

A fuel vaporization chamber was used to produce fuel vapors. The 1.2-liter chamber was equipped with a gas-sampling probe and sensors to measure the pressure and fuel temperature. The chamber was kept isothermal (within 0.2°F) by an Isotemp 10285 bath made by Fisher Scientific. Fuel temperature was measured with a Wavetek 600 series RTD.

The gas-sampling probe was made 0.062-inch internal diameter, electro-polished nickel tubing. The tubing was also used as the transfer line from the probe to the sample loop in the gas chromatograph. The transfer line was enveloped by a 0.25 inch copper tube which was wrapped with heating tape and heated above 250°F. The sample loop temperature was 257°F. A high-temperature bellows valve isolated the gas-sampling probe so that the transfer line and sample loop could be evacuated. This was done so the vapor samples could be extracted into the sample loop.

Fuel vapor analysis was performed with a Hewlett-Packard model 5890 gas chromatograph equipped with a 105-meter x 0.25-millimeter capillary column and a flame ionization detector. Data were acquired with Separation Systems Inc. software designed specifically for high-resolution analysis of complex hydrocarbon mixtures. The retention times and species identifications were obtained using a hydrocarbon standard composed of over 400 identified compounds. The analysis required an elaborate temperature program that gave excellent separation of the species in jet fuel vapors.

4.0 RESULTS

Table 1 is a listing of the fuel sample sources and the measured flash point of each sample.

Table 1. Fuel Sample Sources

Sample ID No.	Refinery	Location	Flash Point, °C	Flash Point, °F
24406	AGE	San Antonio, TX	40	104.0
26305/26306	Mobil	Beaumont, TX	47	116.6
26296/26297	Sun	Marcus Hook, PA	50	122.0
26298/26299	Koch	Ponca City, OK	51	123.8
26442/26443	Exxon	Benecia, CA	62	143.6
26311/26312	FINA	Big Spring, TX	68	154.4

The mole fraction of a component of a vapor is equal to its pressure fraction in the vapor. Therefore, the fuel-related vapor pressure above a liquid fuel is determined by multiplying the decimal mole fraction of the hydrocarbon by the average local atmospheric (ambient) pressure. This is demonstrated in the following example (Equation 1).

Equation (1) $VP_{hc} = X_i \rho_{atm}$

Where:
VP_{hc} = the vapor partial pressure of the fuel
X_i = the decimal mole fraction of the hydrocarbon in the vapor above the fuel
ρ_{atm} = the ambient atmospheric pressure above the fuel

As an example, using the data for sample 24406 at 89.7°F (see Table 2) and assuming 740mm atmospheric pressure:

$VP_{hc} = (0.007641)(740)$
$VP_{hc} = 5.7$mm Hg or 0.1102 p.s.i.

Table 2 contains the temperature and vapor concentration data from the analysis of the test fuels. This table also includes hydrocarbon vapor pressure data for the test fuels (assuming an ambient atmospheric pressure of 740 mm). Figures 2-7 are plots of the data from Table 2. Figures 8 and 9 contain plots of all the data from Table 2 combined on one graph. Figure 8 is a plot using vapor concentration in parts per million while Figure 9 is a plot using vapor concentration in milligrams per liter. Figures 10 and 11 (parts per million and milligrams per liter, respectively) are plots of the equation to model all of the data on a single plot. It is this equation that can be used to estimate vapor concentration based on flash point and storage temperature.

Table 2. Vapor Concentration Data			
Test Temperature, °F	**Hydrocarbon Vapor Concentration, mole parts per million**	**Hydrocarbon Vapor Pressure, mm Hg** and psi**	
Sample 24406			
96*	8602	6.4	0.124
89.7	7641	5.7	0.1102
79.5	5559	4.1	0.0793
69.7	4394	3.3	0.0638
59.7	3091	2.3	0.044
49.9	2192	1.6	0.0309
39.8	1587	1.2	0.0232
* 96°F is the Lower Temperature of Flammability for this fuel. The hydrocarbon concentration at this temperature is an average of 4 determinations.			
Sample 26305			
99.9	5871	4.3	0.0831
89.4	4882	3.6	0.0696
79.6	3831	2.8	0.0541
69.7	2847	2.1	0.0406
59.8	1761	1.3	0.0251
50.0	1430	1.1	0.0213
40.0	920	0.7	0.0135
Sample 26296			
100.0	5708	4.2	0.0812
89.5	4380	3.2	0.0619
79.6	3152	2.3	0.0445
69.8	2295	1.7	0.0329
59.8	1602	1.2	0.0232
50.0	1023	0.8	0.0155
40.0	719	0.5	0.00967
Sample 26298			
99.9	5983	4.4	0.0851
90.0	4816	3.6	0.0696
79.6	3979	2.9	0.0561
69.7	2542	1.9	0.0367
59.9	2043	1.5	0.029005
49.9	1238	0.9	0.0174
39.9	1018	0.8	0.01546
Sample 26442			
100.1	3370	2.5	0.0483
89.5	3001	2.2	0.0425
79.6	2231	1.7	0.03287
69.7	1585	1.2	0.0232
59.8	1304	1.0	0.0193
50.0	1074	0.8	0.0155
40.0	623	0.5	0.00967
Sample 26311			
99.9	2212	1.6	0.0309
89.9	1506	1.1	0.0213
79.6	910	0.7	0.0135
69.7	607	0.4	0.00773
59.8	464	0.3	0.00580
50.0	321	0.2	0.00387
40.0	210	0.2	0.00387
**Based on an average local atmospheric (ambient) pressure of 740 mm. To convert to psi, multiply mm Hg by 0.01933678			

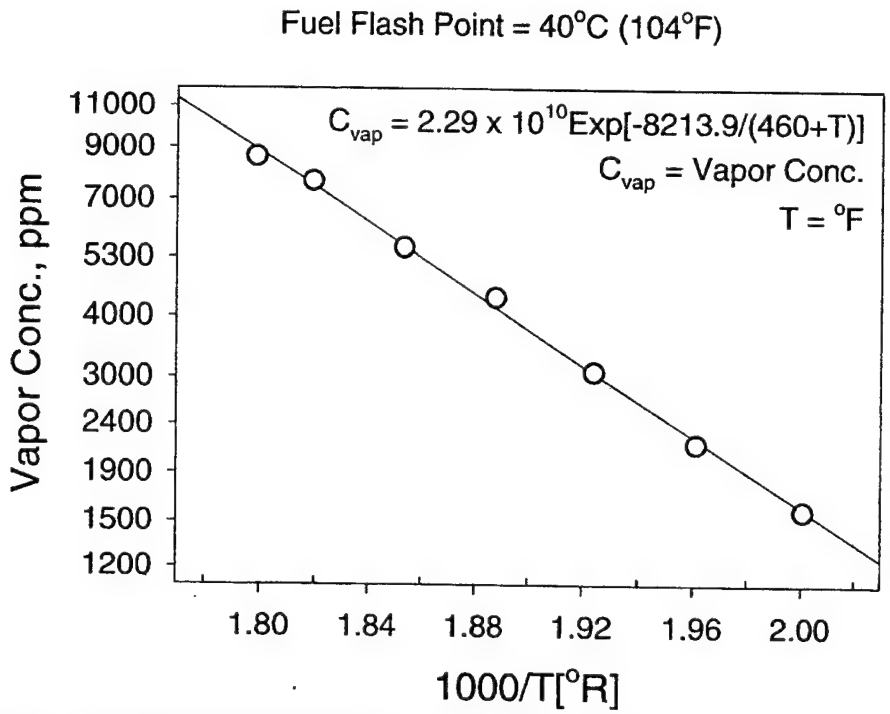


Figure 2. Dependence of JP-8 Vapor Concentration on Temperature: Fuel No. 24406

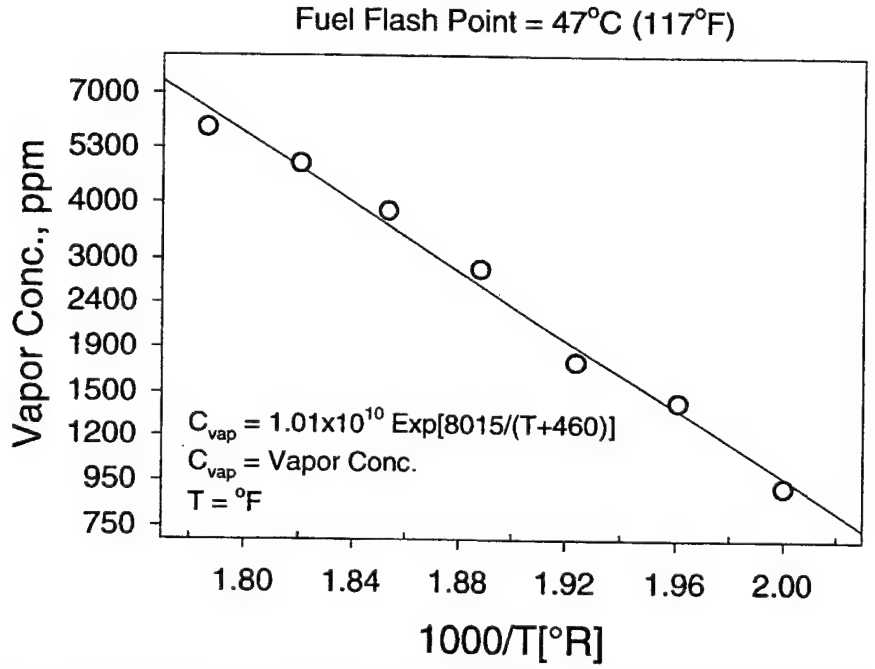


Figure 3. Dependence of JP-8 Vapor Concentration on Temperature: Fuel No. 26305

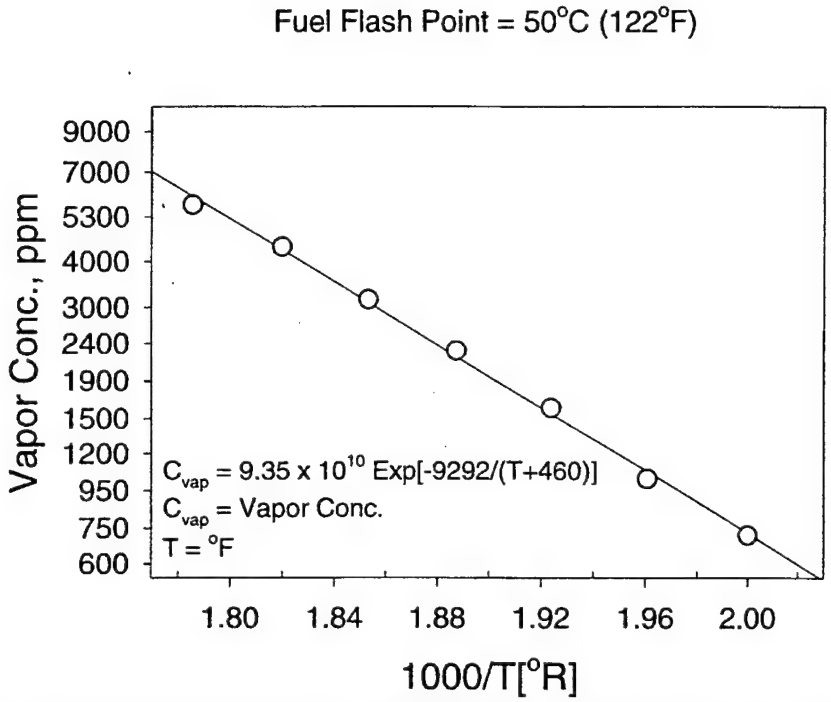


Figure 4. Dependence of JP-8 Vapor Concentration on Temperature: Fuel No. 26296

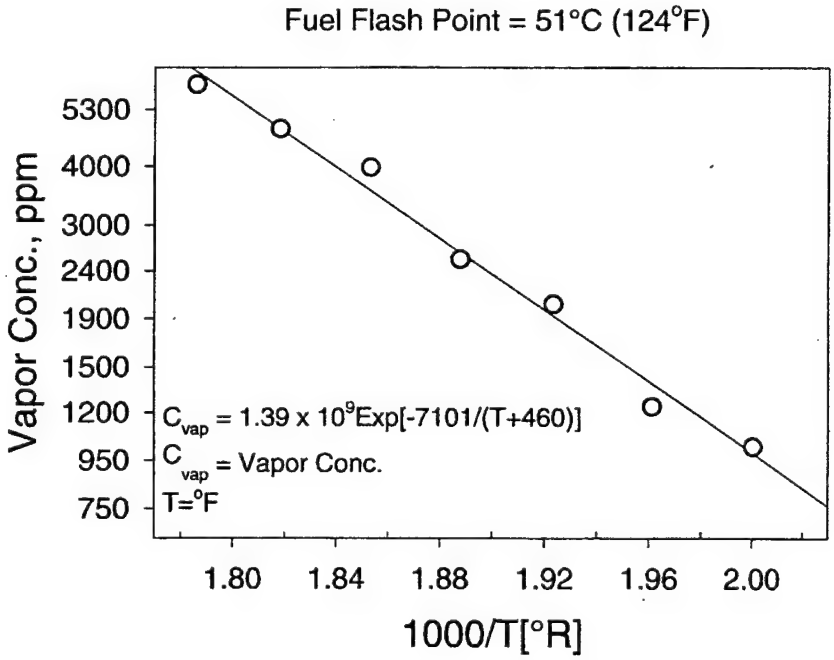


Figure 5. Dependence of JP-8 Vapor Concentration on Temperature: Fuel No. 26298

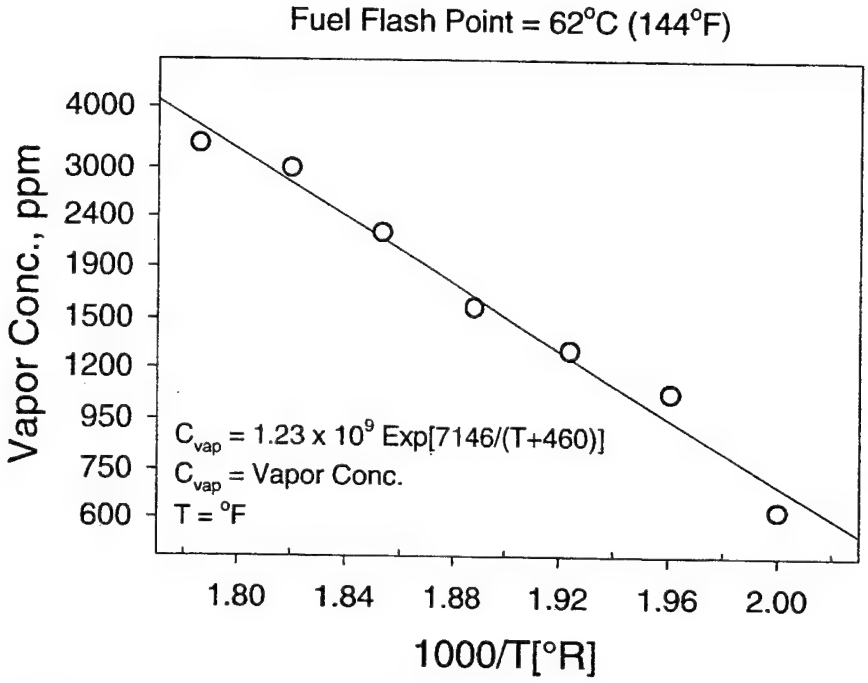


Figure 6. Dependence of JP-8 Vapor Concentration on Temperature: Fuel No. 26442

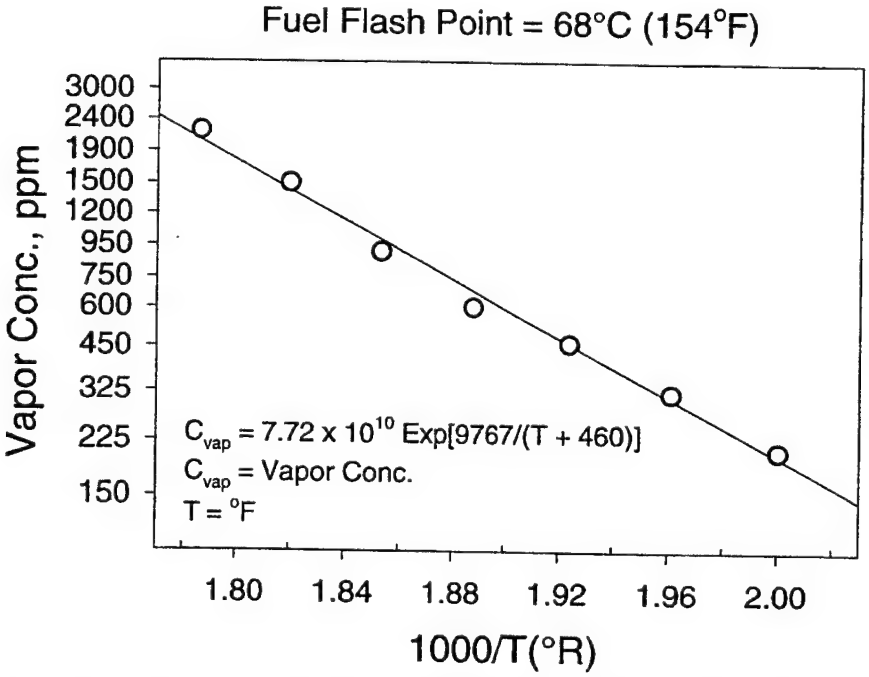


Figure 7. Dependence of JP-8 Vapor Concentration on Temperature: Fuel No. 26311

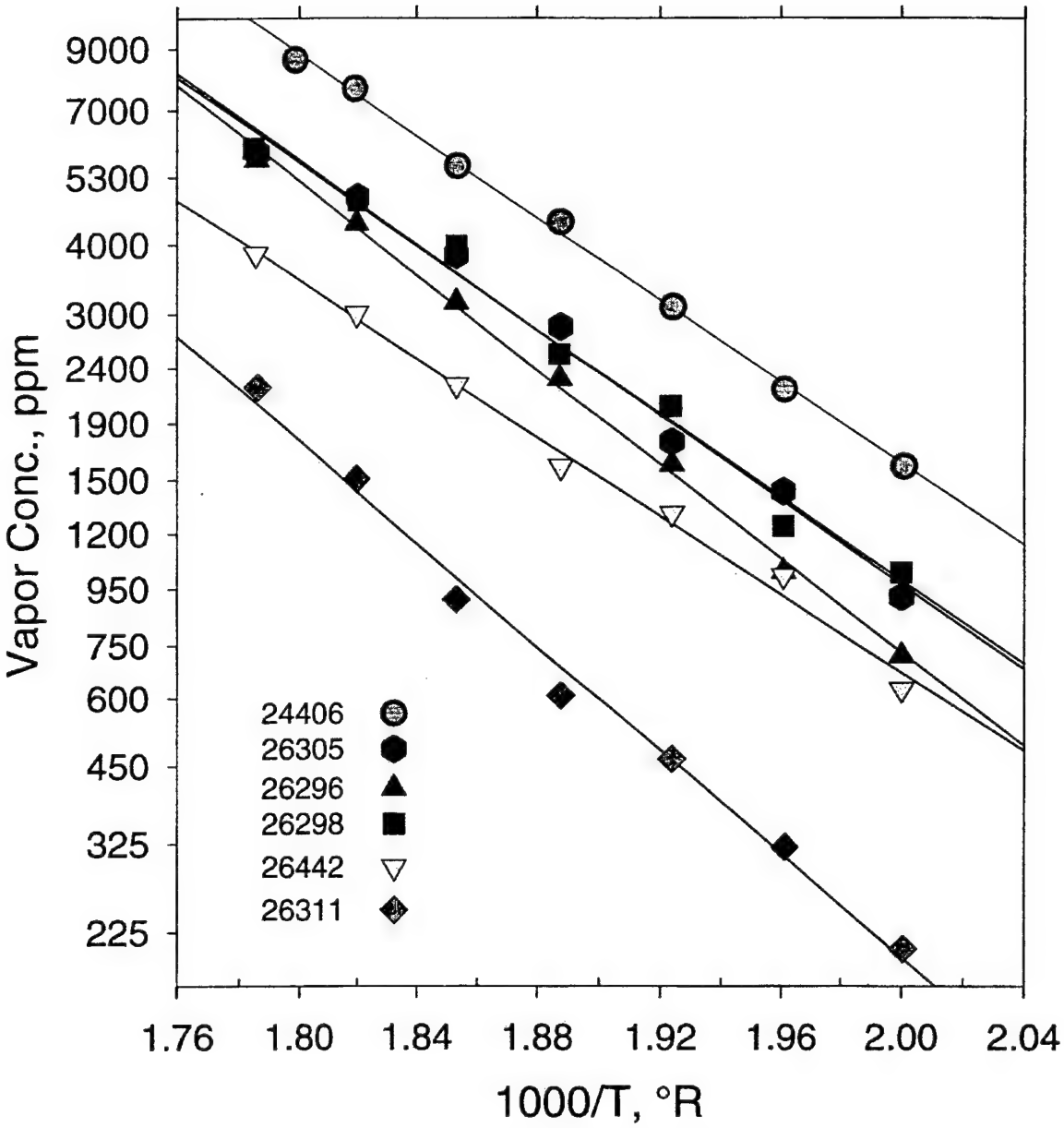


Figure 8. Vapor Concentration (ppm) vs. Temperature (All Fuels)

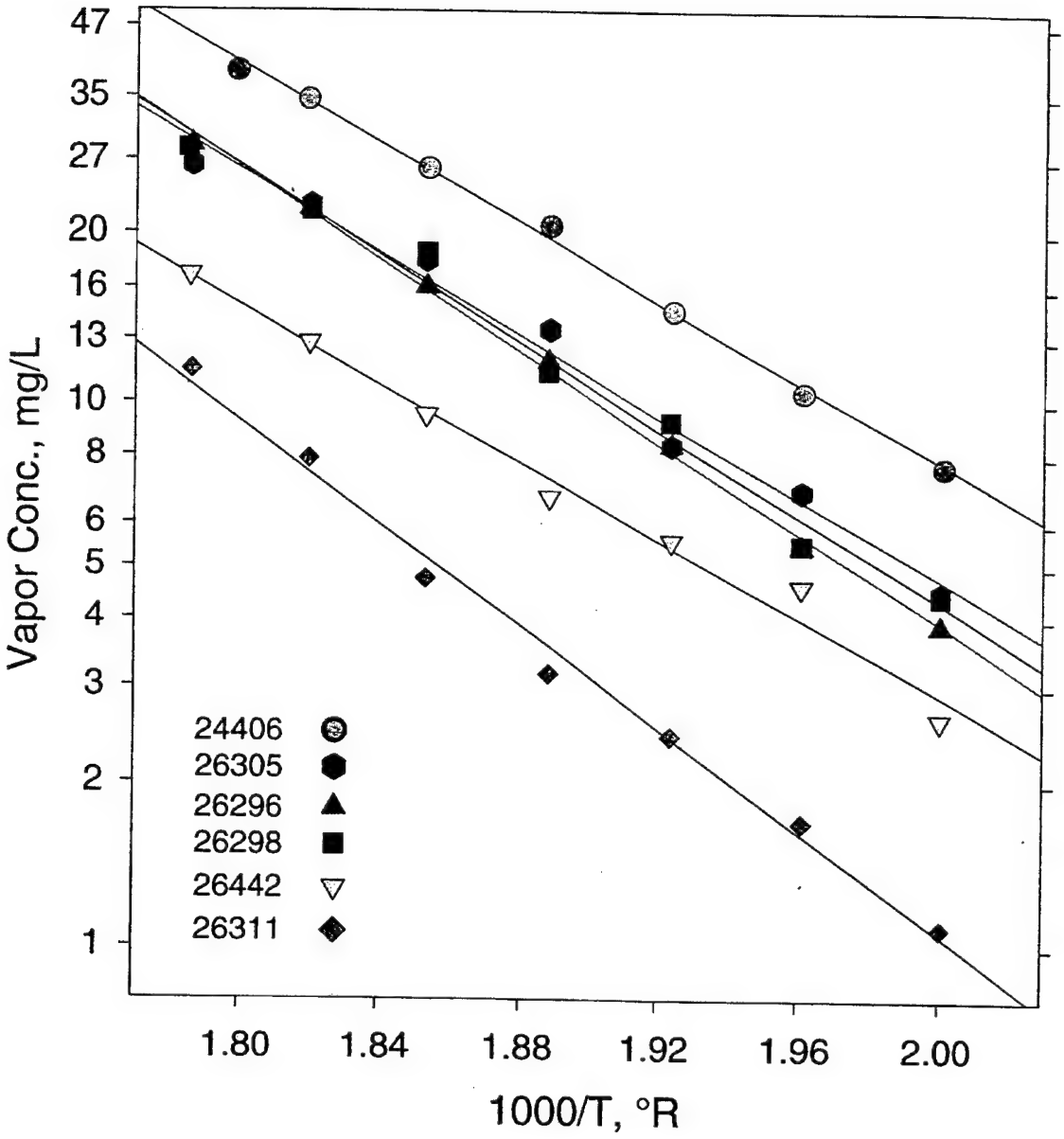


Figure 9. Vapor Concentration (mg/L) vs. Temperature (All Fuels)

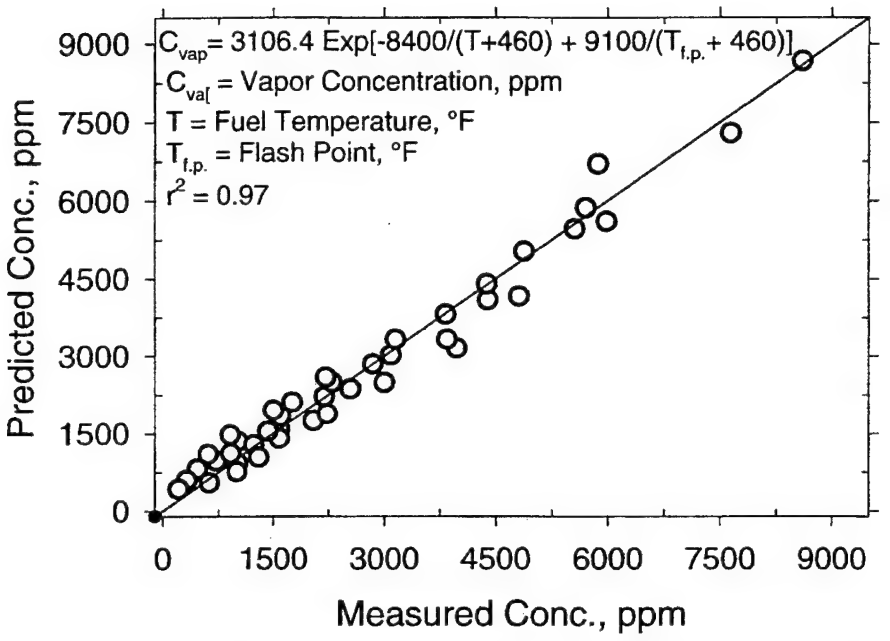


Figure 10. Correlation of Vapor Concentration (ppm) with Temperature and Flash Point

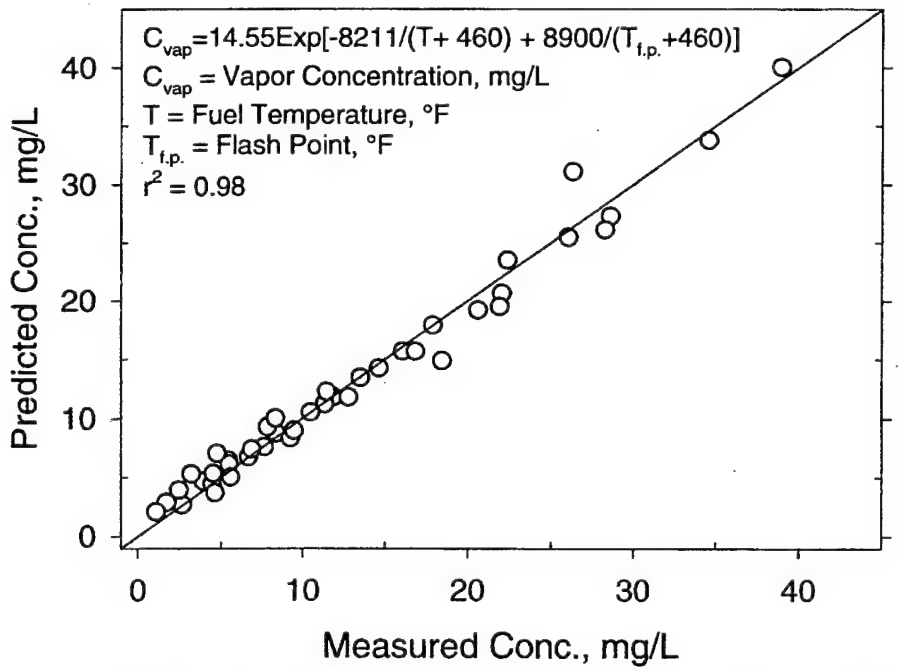


Figure 11. Correlation of Vapor Concentration (mg/L) with Temperature and Flash Point

Table 3 contains the equations for the nonlinear regression fit of the data. Table 3 also contains the composite equation, which describes all the test data.

Figure 12 contains six gas chromatograms. These chromatograms are the plots of the boiling point distribution analysis data for each of the test fuels. They are plotted on a single page for the purposes of comparison. The plots are arranged from the lowest flash point to the highest flash point (top to bottom). Note that as the flash point of the fuel increases, the "front-end" of the fuel moves progressively farther up scale. The complete gas chromatography, boiling point distillation reports are found in Appendix A.

Table 3. Equations for Calculating Vapor Concentration (ppm)

Sample	Equation
24406	$C_{vap} = 2.29 \times 10^{10} \exp[-8213.9/(460+T)]$
26305	$C_{vap} = 1.01 \times 10^{10} \exp[-8015.3/(460+T)]$
26296	$C_{vap} = 9.35 \times 10^{10} \exp[-9291.8/(460+T)]$
26298	$C_{vap} = 1.24 \times 10^{10} \exp[-8126.3/(460+T)]$
26442	$C_{vap} = 1.23 \times 10^{9} \exp[-7146.5/(460+T)]$
26311	$C_{vap} = 3.04 \times 10^{11} \exp[-10518/(460+T)]$
Composite Data	$C_{vap} = 3106.4 \exp[-8400/(T+460) + 9100/(T_{fp}+460)]$

C_{vap} = Vapor Concentration T = temperature, °F T_{fp} = flash point, °F

Calculating Vapor Pressure Values

As an example, for a JP-8 with a flash point of 110°F and stored at 80°F, the vapor concentration would be:

Cvap = 3106.4 exp[-8400/(80+460) + 9100/(110+460)]

Cvap = 3106.4 exp[0.4]

Cvap = 4628 mole parts per million (and the decimal mole fraction of hydrocarbon in the vapor above the fuel would be 0.004628)

Assuming an atmospheric pressure of 740 mm Hg, and substituting into Equation (1), gives a calculated vapor pressure of:

$$(0.004628)(740) = 3.42 \text{ mm Hg}$$

$$(3.42 \text{ mm})(0.01933678 \text{ p.s.i./mm}) = 0.07 \text{ psi}$$

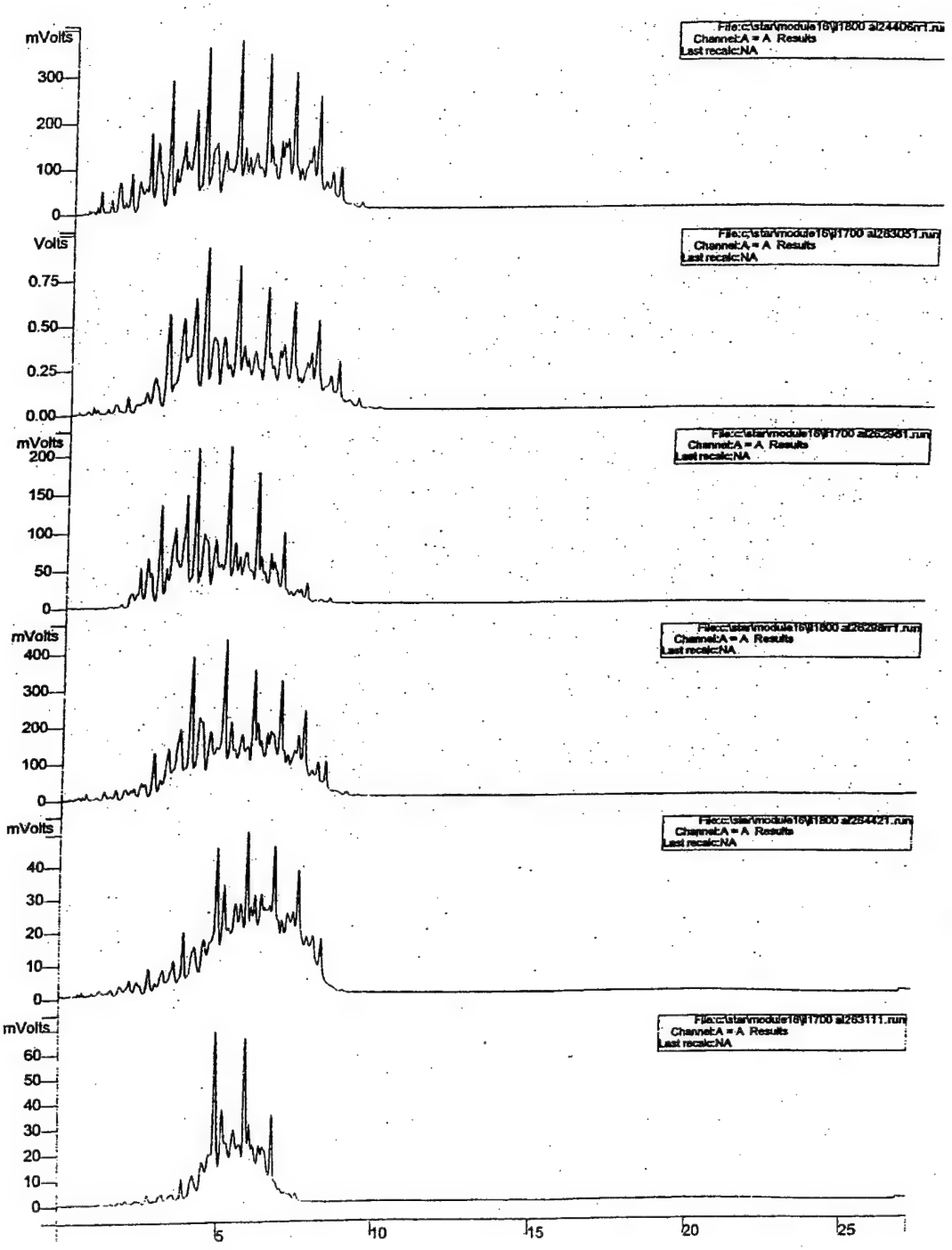


Figure 12. Boiling Point Distribution by Gas Chromatography

Table 4 is a summary of vapor pressure results, by ASTM D 5191, for the six test fuels at the four test temperatures. Recall that these results include the partial pressure of the air entrained in the sample. The results obtained by the gas chromatographic method are also presented in the table for comparison. Examination of all the data shows that ASTM D 5191 is indeed less sensitive than the gas chromatographic method. This is as expected since D 5191 was developed for fuels with vapor pressure of 1 psi or higher. Use of the gas chromatographic method provides a measurement of the vapor partial pressure for the hydrocarbons and not the entrained air.

Table 5 is a lookup table provided for the convenience of the reader. The calculated vapor partial pressure is based on an atmospheric pressure of 740 mm Hg.

Table 6 summarizes the findings of the analysis of fuel vapors for hazardous air pollutants. These data were obtained by comparing the results of the vapor speciation analysis with the published list of hazardous air pollutants. Many factors control the concentration of these compounds in a given finished fuel. For this reason, the average concentrations should be used to describe an average fuel.

Table 4. Comparison of Vapor Pressure Results measured by ASTM D 5191 with Results Calculated from Gas Chromatography Data, p.s.i.

Sample No.	40°F		60°F		80°F		100°F	
	D 5191	GC	D 5191	GC	D 5191	GC	D 5191	GC
24406	0.06	0.02	0.06	0.04	0.20	0.08	0.26	0.1
26305	0.09	0.01	0.11	0.03	0.26	0.05	0.32	0.08
26296	0.06	0.01	0.06	0.02	0.16	0.04	0.26	0.08
26298	0.02	0.02	0.02	0.03	0.16	0.06	0.19	0.09
26442	0.05	0.01	0.06	0.02	0.20	0.03	0.22	0.05
26311	0.04	<0.01	0.05	0.01	0.19	0.01	0.21	0.03

Table 5. JP-8 Vapor Partial Pressure Look-Up Table as Calculated from Gas Chromatography Data (Assuming an Atmospheric Pressure of 740 mm Hg)							
Part a. Partial Pressure in p.s.i.							
Flash Point, °F	**Fuel Temperature, °F**						
	40	**50**	**60**	**70**	**80**	**90**	**100**
100	0.03	0.04	0.05	0.07	0.09	0.12	0.16
105	0.02	0.03	0.04	0.06	0.08	0.10	0.13
110	0.02	0.03	0.04	0.05	0.07	0.09	0.12
115	0.02	0.02	0.03	0.04	0.06	0.08	0.10
120	0.01	0.02	0.03	0.04	0.05	0.07	0.09
125	0.01	0.02	0.02	0.03	0.04	0.06	0.08
130	0.01	0.02	0.02	0.03	0.04	0.05	0.07
135	0.01	0.01	0.02	0.03	0.03	0.05	0.06
140	0.01	0.01	0.02	0.02	0.03	0.04	0.05
145	0.01	0.01	0.01	0.02	0.03	0.04	0.05
150	0.01	0.01	0.01	0.02	0.02	0.03	0.04
155	0.01	0.01	0.01	0.02	0.02	0.03	0.04
160	0.01	0.01	0.01	0.01	0.02	0.02	0.03
Part b. Partial Pressure in mm of Hg							
Flash Point, °F	**Fuel Temperature, °F**						
	40	**50**	**60**	**70**	**80**	**90**	**100**
100	1.33	1.84	2.53	3.43	4.60	6.11	8.02
105	1.15	1.60	2.19	2.97	3.99	5.29	6.95
110	1.00	1.39	1.90	2.58	3.46	4.59	6.03
115	0.87	1.21	1.66	2.25	3.01	4.00	5.25
120	0.76	1.05	1.45	1.96	2.63	3.49	4.58
125	0.66	0.92	1.26	1.71	2.30	3.05	4.01
130	0.58	0.81	1.11	1.50	2.01	2.67	3.51
135	0.51	0.71	0.97	1.32	1.77	2.35	3.08
140	0.45	0.62	0.86	1.16	1.56	2.07	2.72
145	0.40	0.55	0.76	1.02	1.37	1.82	2.40
150	0.35	0.49	0.67	0.91	1.22	1.61	2.12
155	0.31	0.43	0.59	0.80	1.08	1.43	1.88
160	0.28	0.38	0.53	0.71	0.96	1.27	1.66

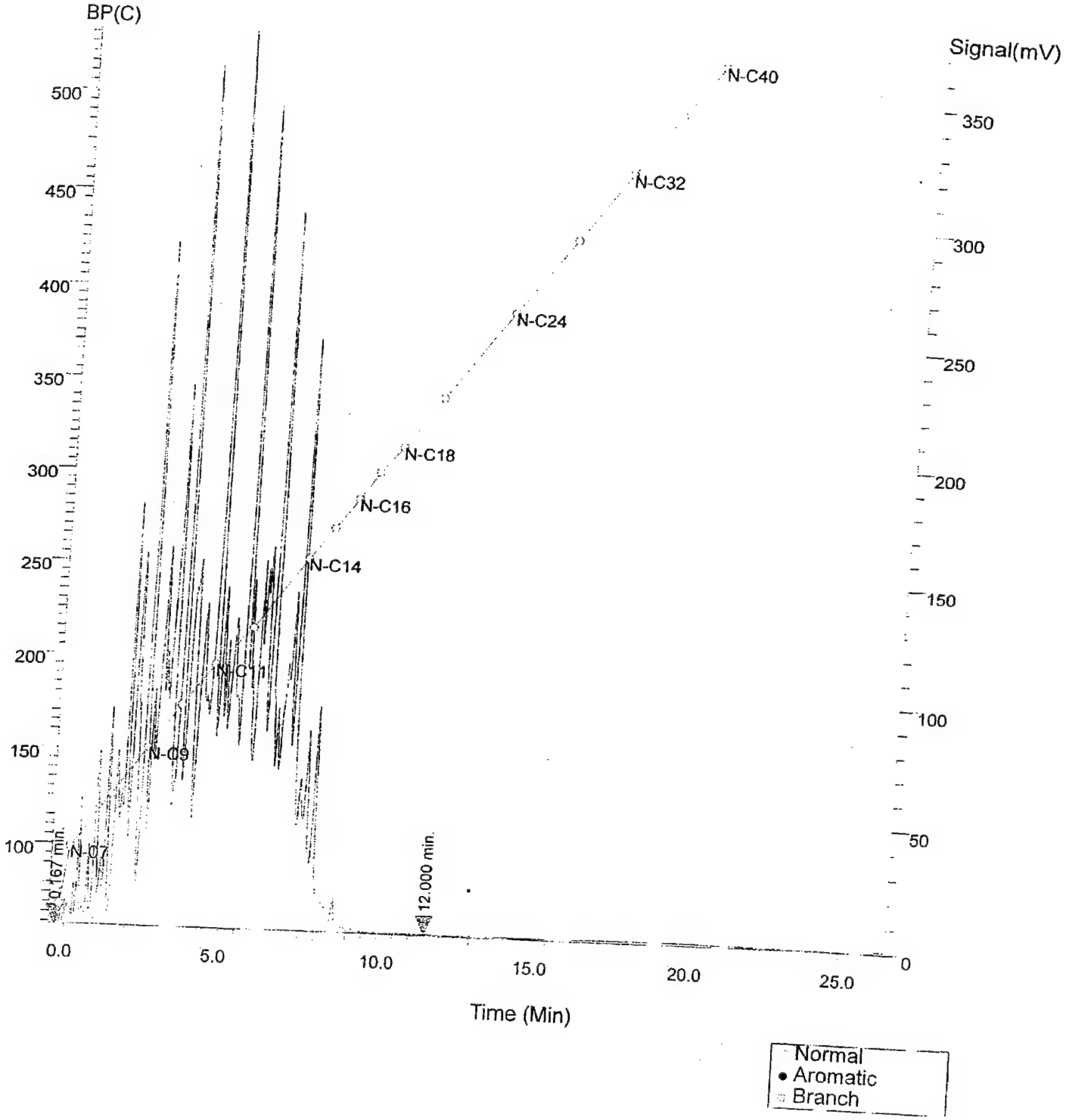
Table 6. Concentration of JP-8 Vapor Hazardous Air Pollutants, wt%										
Compound	**CAS Number**	**Molecular Formula**	**Boiling Pt (°C)**	**24406**	**26305**	**26296**	**26298**	**26442**	**26311**	**Average**
Benzene	71-43-2	C_6H_6	80.1	0.16	0.36	0.01	0.34	0.34	0.002	0.20
1,3-Butadiene	106-99-0	C_4H_6	-4.5	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
Cumene	98-82-8	C_9H_{12}	152	<1	0.24	0.43	0.25	0.14	0.38	0.29
Ethyl benzene	100-41-4	C_8H_{10}	136	1.13	1.02	0.89	0.63	0.81	0.69	0.86
Hexane	110-54-3	C_6H_{14}	69	0.55	2.09	0.03	1.29	1.03	0.07	0.84
Naphthalene	91-20-3	$C_{10}H_8$	218	0.02	0.12	<0.01	0.46	0.43	0.85	0.38
Toluene	108-88-3	C_7H_8	110.6	3.75	2.33	0.06	1.29	2.07	0.37	1.65
2,2,4-Trimethylpentane	540-84-1	C_8H_{18}	99.3	<0.01	0.01	<0.01	0.01	<0.01	0.04	0.02
o-Xylenes	95-47-6	C_8H_{10}	144	2.34	1.63	3.38	0.59	1.13	0.59	1.61
m-Xylenes	108-38-3	C_8H_{10}	138.3	4.64	1.93	4.34	0.98	1.83	0.79	2.42
p-Xylenes	106-42-3	C_8H_{10}	137	1.04	0.81	1.24	0.31	0.59	0.27	0.71

APPENDIX A
BOILING POINT DATA

File: C:\Star\Module16\JL1800 AL24406RR1.CDF
Sample: JL1800 AL24406RR
Parameter: D2887

JUL 18, 2000 - 15:31:29
Operator:

Calibration Curve
ASTM D2887



File: C:\Star\Module16\JL1800 AL24406RR1.CDF
Sample: JL1800 AL24406RR
Parameter: D2887

JUL 18, 2000 - 15:31:29
Operator:

Boiling Point Table

ASTM D2887

%Off	BP(C)	%Off	BP(C)	%Off	BP(C)
IBP	104.1	45.0	193.9	90.0	250.2
1.0	109.9	46.0	195.4	91.0	251.5
2.0	117.0	47.0	196.3	92.0	252.3
3.0	122.4	48.0	196.8	93.0	253.1
4.0	125.2	49.0	197.2	94.0	255.2
5.0	130.7	50.0	197.5	95.0	258.5
6.0	133.9	51.0	198.3	96.0	261.9
7.0	136.4	52.0	199.8	97.0	264.4
8.0	137.4	53.0	200.8	98.0	268.8
9.0	140.1	54.0	202.0	99.0	273.3
10.0	141.7	55.0	203.3	FBP	281.3
11.0	142.8	56.0	204.7		
12.0	144.5	57.0	206.0		
13.0	148.7	58.0	207.1		
14.0	149.8	59.0	208.3		
15.0	150.4	60.0	209.7		
16.0	151.0	61.0	211.1		
17.0	153.5	62.0	212.5		
18.0	155.5	63.0	213.1		
19.0	157.6	64.0	213.6		
20.0	159.1	65.0	214.0		
21.0	160.2	66.0	214.5		
22.0	161.7	67.0	215.6		
23.0	163.2	68.0	216.7		
24.0	165.0	69.0	218.4		
25.0	166.3	70.0	220.5		
26.0	167.3	71.0	222.4		
27.0	168.1	72.0	223.6		
28.0	169.1	73.0	225.0		
29.0	172.0	74.0	226.2		
30.0	173.7	75.0	227.4		
31.0	174.5	76.0	228.6		
32.0	175.1	77.0	230.1		
33.0	175.5	78.0	231.9		
34.0	176.2	79.0	232.8		
35.0	178.5	80.0	233.4		
36.0	179.9	81.0	234.0		
37.0	181.0	82.0	235.2		
38.0	182.2	83.0	237.2		
39.0	183.3	84.0	239.4		
40.0	186.0	85.0	241.8		
41.0	187.6	86.0	243.7		
42.0	188.9	87.0	245.3		
43.0	190.3	88.0	246.9		
44.0	192.1	89.0	248.2		

Recovery: 100.0
Analysis Area: 1.0873e+05
Sample Amt: 1.0000
R.Time Date: 6/23/2000
R.Factor Date:

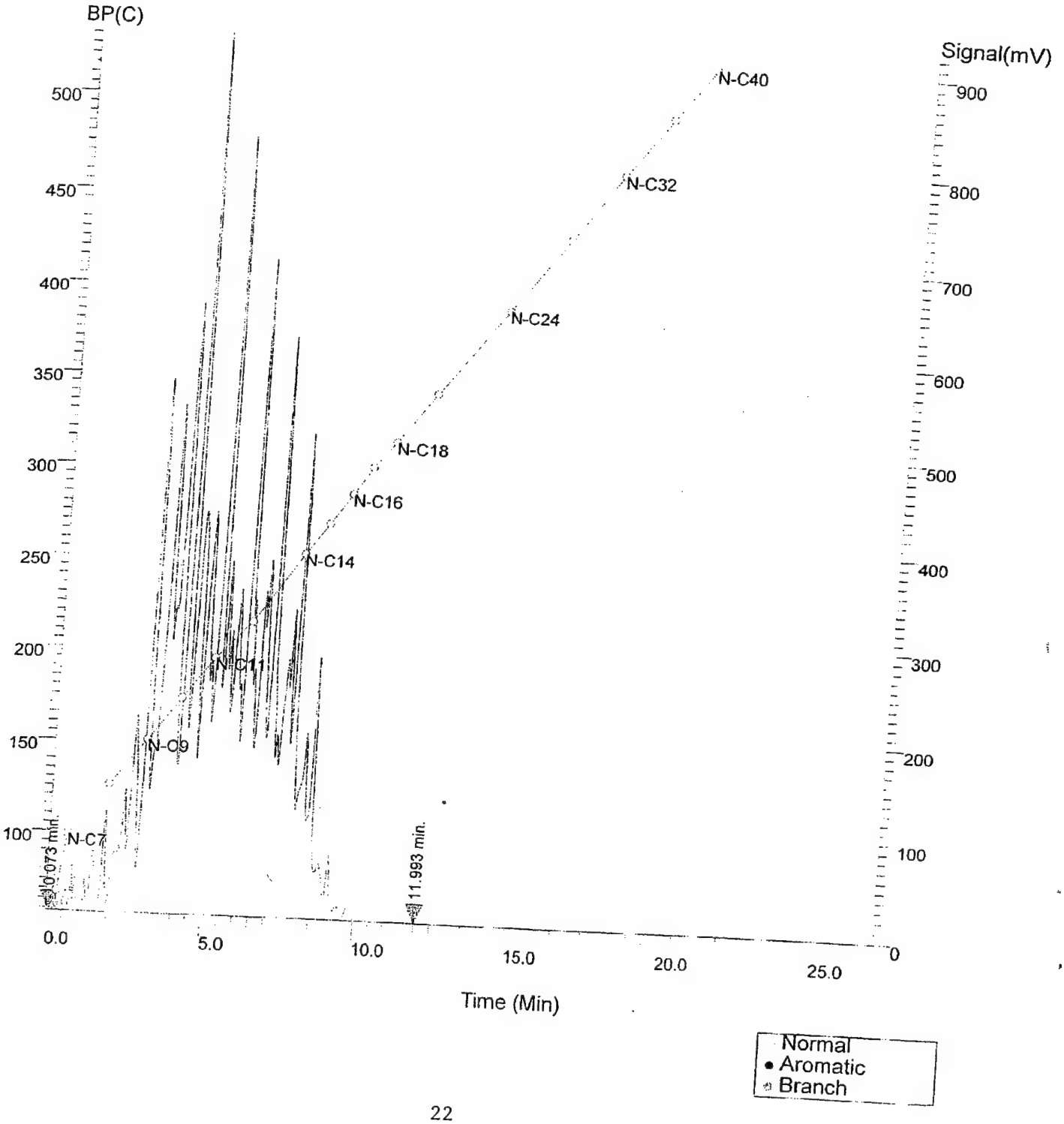
Start Time: 0.17 min.
Start Signal: 0.000 mV
Solvent Amt: 1.0000
R.Time File: C:\Star\Module16\D2887ST20C J2000 1M1001.CDF
R.Factor File:
Blank File:

End Time: 12.00 min.
End Signal: 0.319 mV

File: C:\Star\Module16\JL1700 AL263051.CDF
Sample: JL1700 AL26305
Parameter: D2887

JUL 17, 2000 - 14:42:40
Operator:

Calibration Curve
ASTM D2887



File: C:\Star\Module16\JL1700 AL263051.CDF
Sample: JL1700 AL26305
Parameter: D2887

JUL 17, 2000 - 14:42:40
Operator:

Boiling Point Table

ASTM D2887

%Off	BP(C)	%Off	BP(C)	%Off	BP(C)
IBP	106.0	45.0	195.0	90.0	253.7
1.0	117.4	46.0	196.8	91.0	254.7
2.0	127.9	47.0	197.8	92.0	255.6
3.0	136.4	48.0	198.4	93.0	258.1
4.0	140.8	49.0	198.9	94.0	261.5
5.0	143.4	50.0	199.4	95.0	264.3
6.0	145.9	51.0	199.8	96.0	267.2
7.0	150.3	52.0	200.6	97.0	270.6
8.0	151.4	53.0	201.8	98.0	272.6
9.0	152.2	54.0	202.8	99.0	280.4
10.0	153.0	55.0	203.8	FBP	286.3
11.0	155.3	56.0	205.0		
12.0	157.8	57.0	206.3		
13.0	159.6	58.0	207.7		
14.0	160.9	59.0	208.8		
15.0	161.8	60.0	209.8		
16.0	162.6	61.0	211.0		
17.0	163.5	62.0	212.4		
18.0	164.8	63.0	214.0		
19.0	166.2	64.0	214.8		
20.0	167.5	65.0	215.4		
21.0	168.6	66.0	215.9		
22.0	169.4	67.0	216.5		
23.0	170.2	68.0	217.9		
24.0	170.8	69.0	219.3		
25.0	171.6	70.0	221.0		
26.0	173.4	71.0	223.2		
27.0	175.5	72.0	225.0		
28.0	176.5	73.0	226.3		
29.0	177.1	74.0	227.7		
30.0	177.7	75.0	228.9		
31.0	178.2	76.0	230.4		
32.0	178.6	77.0	232.6		
33.0	179.5	78.0	234.2		
34.0	181.4	79.0	235.2		
35.0	182.6	80.0	236.0		
36.0	183.6	81.0	236.8		
37.0	184.5	82.0	238.4		
38.0	185.5	83.0	240.7		
39.0	186.8	84.0	243.3		
40.0	188.8	85.0	245.4		
41.0	189.9	86.0	247.1		
42.0	190.9	87.0	248.8		
43.0	192.0	88.0	250.2		
44.0	193.5	89.0	252.3		

Recovery: 100.0
Analysis Area: 2.7265e+05
Sample Amt: 1.0000
R.Time Date: 6/23/2000
R.Factor Date:

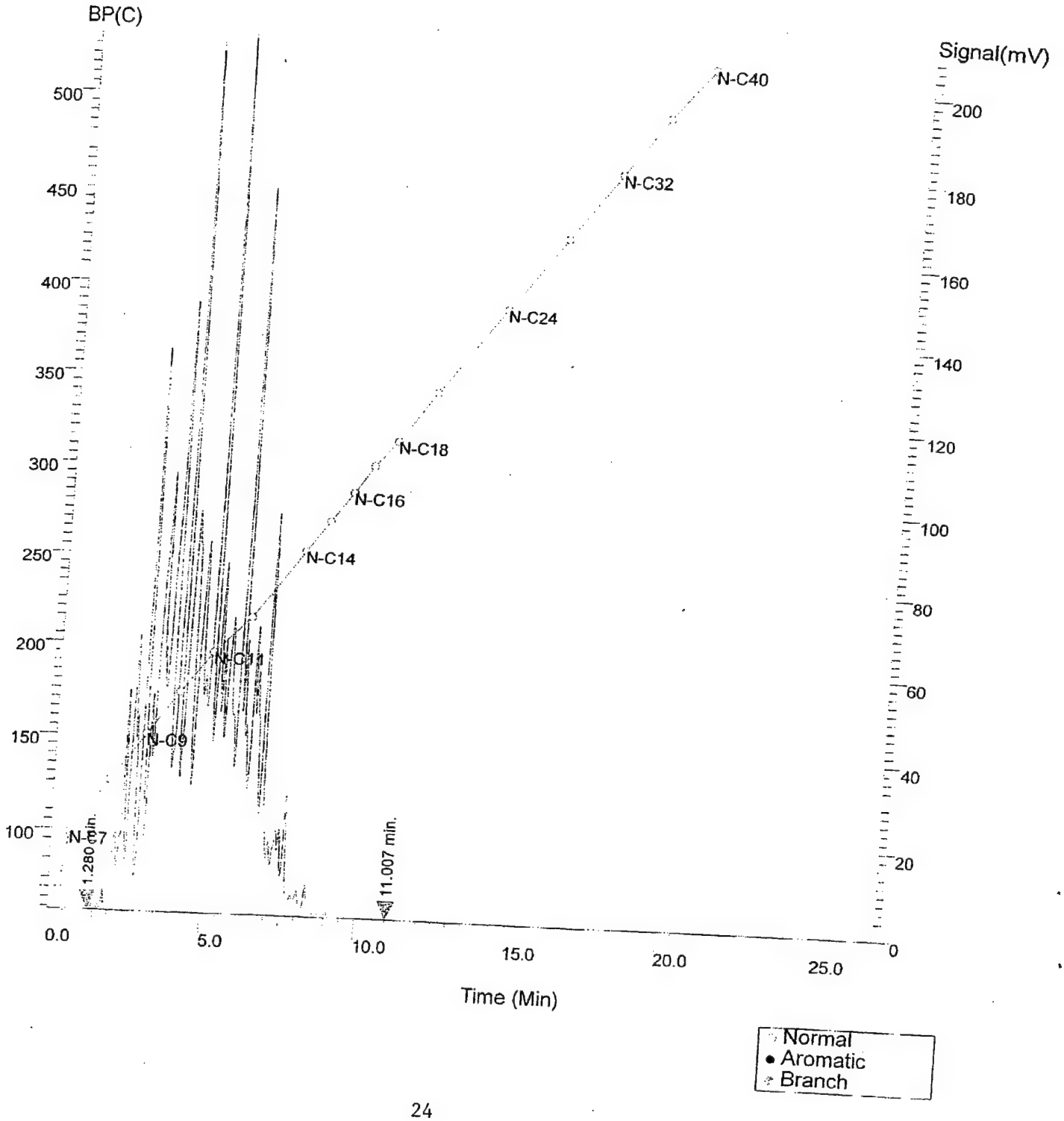
Start Time: 0.07 min.
Start Signal: 0.080 mV
Solvent Amt: 1.0000
R.Time File: C:\Star\Module16\D2887ST20C J2000 1M1001.CDF
R.Factor File:
Blank File:

End Time: 11.99 min.
End Signal: 0.000 mV

File: C:\Star\Module16\JL1700 AL262961.CDF
Sample: JL1700 AL26296
Parameter: D2887

JUL 17, 2000 - 15:20:48
Operator:

Calibration Curve
ASTM D2887



File: C:\Star\Module16\JL1700 AL262961.CDF
Sample: JL1700 AL26296
Parameter: D2887

JUL 17, 2000 - 15:20:48
Operator:

Boiling Point Table

ASTM D2887

%Off	BP(C)	%Off	BP(C)	%Off	BP(C)
IBP	130.6	45.0	183.3	90.0	227.2
1.0	132.5	46.0	184.7	91.0	229.2
2.0	136.6	47.0	186.5	92.0	231.4
3.0	138.2	48.0	187.5	93.0	232.3
4.0	141.3	49.0	188.3	94.0	233.1
5.0	142.4	50.0	189.0	95.0	235.8
6.0	143.7	51.0	190.0	96.0	240.7
7.0	145.4	52.0	191.3	97.0	245.0
8.0	149.0	53.0	192.5	98.0	250.0
9.0	149.8	54.0	193.8	99.0	255.9
10.0	150.3	55.0	195.0	FBP	263.7
11.0	150.9	56.0	195.8		
12.0	152.3	57.0	196.3		
13.0	154.6	58.0	196.6		
14.0	156.3	59.0	196.9		
15.0	157.8	60.0	197.1		
16.0	158.7	61.0	197.5		
17.0	159.5	62.0	198.3		
18.0	160.2	63.0	199.5		
19.0	160.9	64.0	200.3		
20.0	161.9	65.0	201.0		
21.0	163.1	66.0	201.9		
22.0	164.4	67.0	202.9		
23.0	165.5	68.0	203.8		
24.0	166.3	69.0	205.0		
25.0	167.0	70.0	206.0		
26.0	167.5	71.0	206.8		
27.0	168.0	72.0	207.6		
28.0	168.5	73.0	208.6		
29.0	169.3	74.0	209.7		
30.0	171.0	75.0	211.0		
31.0	172.8	76.0	212.2		
32.0	173.8	77.0	212.8		
33.0	174.3	78.0	213.1		
34.0	174.7	79.0	213.4		
35.0	175.0	80.0	213.8		
36.0	175.4	81.0	214.4		
37.0	175.8	82.0	215.4		
38.0	177.1	83.0	216.4		
39.0	178.7	84.0	218.0		
40.0	179.6	85.0	220.0		
41.0	180.3	86.0	222.0		
42.0	181.0	87.0	223.1		
43.0	181.8	88.0	224.4		
44.0	182.5	89.0	225.7		

Recovery: 100.0
Analysis Area: 4.4099e+04
Sample Amt: 1.0000
R.Time Date: 6/23/2000
R.Factor Date:

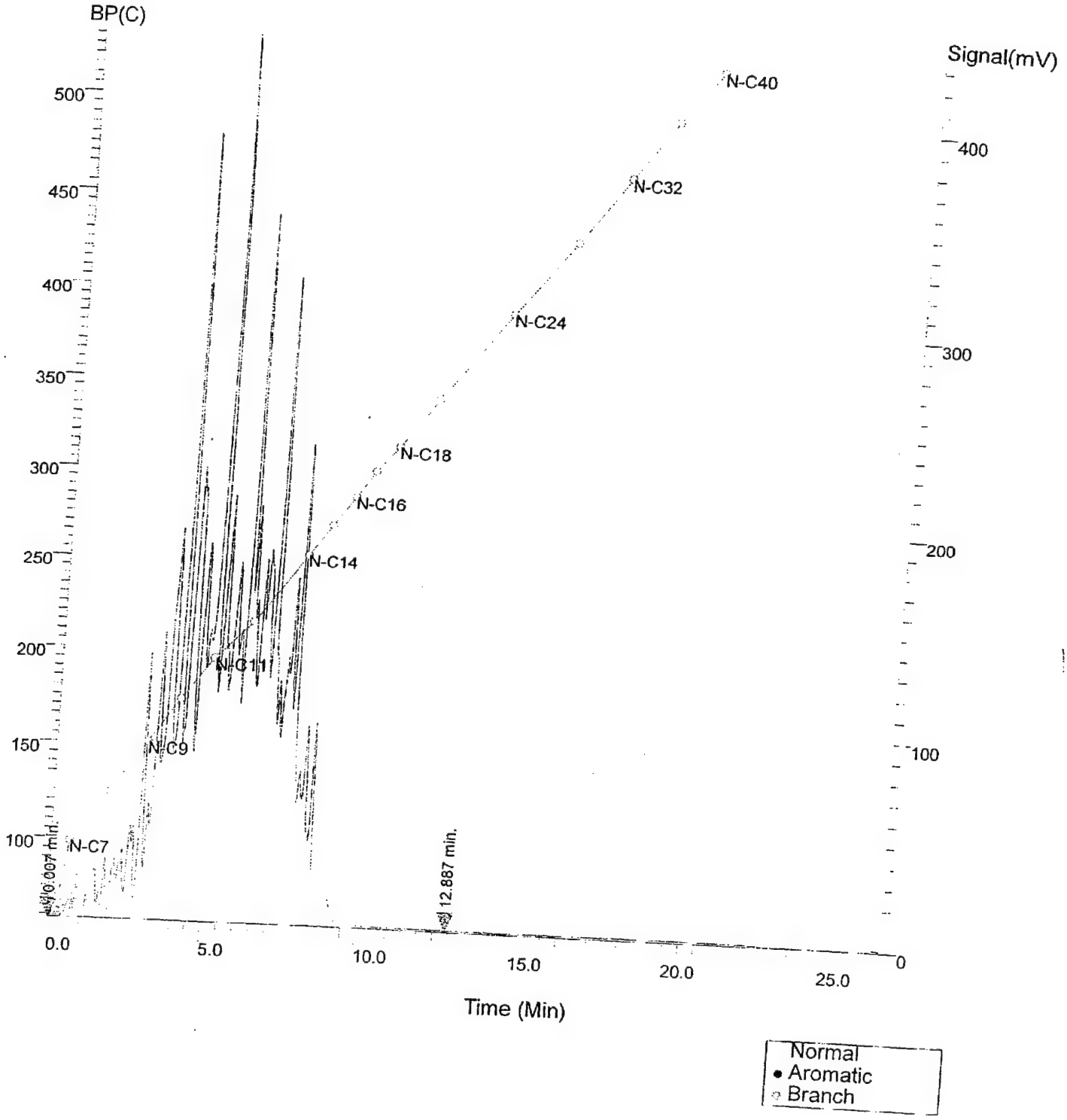
Start Time: 1.28 min.
Start Signal: 0.000 mV
Solvent Amt: 1.0000
R.Time File: C:\Star\Module16\D2887ST20C J2000 1M1001.CDF
R.Factor File:
Blank File:

End Time: 11.01 min.
End Signal: 0.000 mV

File: C:\Star\Module16\JL1800 AL26298RR1.CDF
Sample: JL1800 AL26298RR
Parameter: D2887

JUL 18, 2000 - 14:34:43
Operator:

Calibration Curve
ASTM D2887



File: C:\Star\Module16\JL1800 AL26298RR1.CDF
Sample: JL1800 AL26298RR
Parameter: D2887

JUL 18, 2000 - 14:34:43
Operator:

Boiling Point Table

ASTM D2887

%Off	BP(C)	%Off	BP(C)	%Off	BP(C)
IBP	106.4	45.0	200.3	90.0	251.5
1.0	117.4	46.0	201.0	91.0	252.4
2.0	130.9	47.0	201.8	92.0	253.3
3.0	139.3	48.0	202.9	93.0	255.4
4.0	143.9	49.0	204.0	94.0	258.3
5.0	149.1	50.0	205.2	95.0	261.2
6.0	151.0	51.0	206.3	96.0	263.4
7.0	155.6	52.0	207.1	97.0	267.0
8.0	158.2	53.0	208.0	98.0	269.6
9.0	159.6	54.0	209.1	99.0	277.9
10.0	161.5	55.0	210.1	FBP	288.2
11.0	163.8	56.0	211.2		
12.0	165.4	57.0	212.4		
13.0	166.6	58.0	213.1		
14.0	167.6	59.0	213.6		
15.0	168.7	60.0	214.0		
16.0	170.5	61.0	214.5		
17.0	172.6	62.0	215.4		
18.0	173.8	63.0	216.1		
19.0	174.5	64.0	217.1		
20.0	175.1	65.0	218.4		
21.0	175.5	66.0	219.7		
22.0	176.2	67.0	221.3		
23.0	178.1	68.0	222.7		
24.0	179.5	69.0	223.8		
25.0	180.4	70.0	225.0		
26.0	181.2	71.0	226.1		
27.0	182.0	72.0	227.2		
28.0	182.9	73.0	228.3		
29.0	184.0	74.0	229.5		
30.0	185.9	75.0	231.1		
31.0	187.3	76.0	232.3		
32.0	188.3	77.0	233.1		
33.0	189.3	78.0	233.7		
34.0	190.6	79.0	234.4		
35.0	192.0	80.0	235.7		
36.0	193.3	81.0	237.3		
37.0	194.6	82.0	239.1		
38.0	195.7	83.0	240.9		
39.0	196.4	84.0	242.8		
40.0	196.9	85.0	244.4		
41.0	197.2	86.0	246.0		
42.0	197.6	87.0	247.3		
43.0	198.1	88.0	248.5		
44.0	199.2	89.0	250.2		

Recovery: 100.0
Analysis Area: 1.1918e+05
Sample Amt: 1.0000
R.Time Date: 6/23/2000
R.Factor Date:

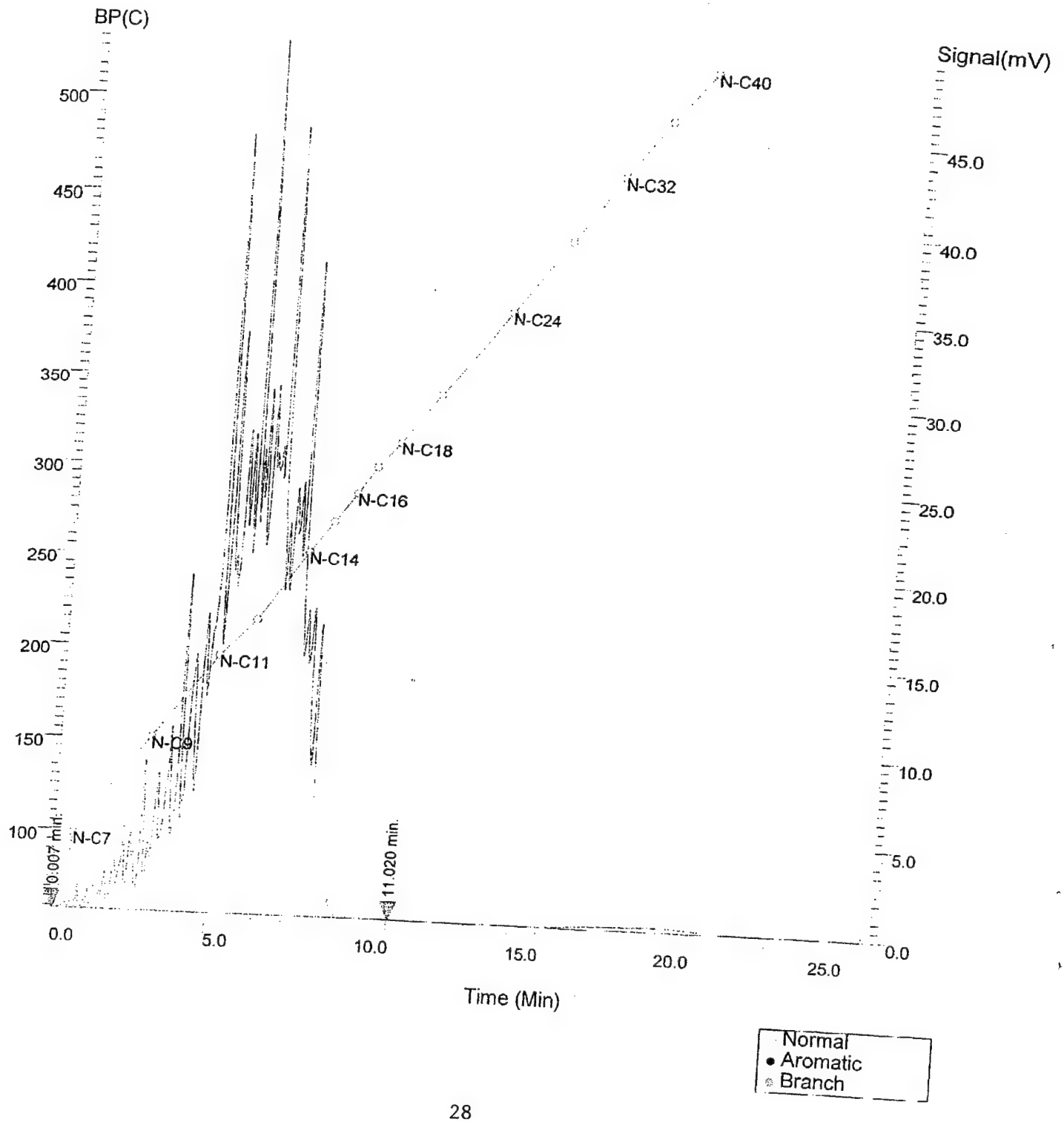
Start Time: 0.01 min.
Start Signal: 0.000 mV
Solvent Amt: 1.0000
R.Time File: C:\Star\Module16\D2887ST20C J2000 1M1001.CDF
R.Factor File:
Blank File:

End Time: 12.89 min.
End Signal: 0.597 mV

File: C:\Star\Module16\JL1800 AL264421.CDF
Sample: JL1800 AL26442
Parameter: D2887

JUL 18, 2000 - 09:08:34
Operator:

Calibration Curve
ASTM D2887



File: C:\Star\Module16\JL1800 AL264421.CDF
Sample: JL1800 AL26442
Parameter: D2887

JUL 18, 2000 - 09:08:34
Operator:

Boiling Point Table

ASTM D2887

%Off	BP(C)	%Off	BP(C)	%Off	BP(C)
IBP	116.7	45.0	212.2	90.0	254.7
1.0	128.2	46.0	212.7	91.0	256.3
2.0	137.1	47.0	213.3	92.0	257.7
3.0	147.0	48.0	214.1	93.0	259.3
4.0	152.5	49.0	214.8	94.0	260.9
5.0	157.9	50.0	215.5	95.0	262.3
6.0	162.6	51.0	216.3	96.0	264.2
7.0	165.8	52.0	217.1	97.0	266.8
8.0	169.7	53.0	218.0	98.0	268.5
9.0	172.5	54.0	219.2	99.0	272.1
10.0	174.0	55.0	220.3	FBP	276.7
11.0	177.5	56.0	221.2		
12.0	179.4	57.0	222.0		
13.0	181.0	58.0	222.9		
14.0	183.5	59.0	223.9		
15.0	185.7	60.0	224.8		
16.0	187.1	61.0	225.7		
17.0	188.8	62.0	226.7		
18.0	190.4	63.0	227.6		
19.0	191.8	64.0	228.6		
20.0	193.1	65.0	229.5		
21.0	194.2	66.0	230.4		
22.0	194.9	67.0	231.0		
23.0	195.4	68.0	231.5		
24.0	196.0	69.0	232.2		
25.0	196.8	70.0	233.0		
26.0	198.0	71.0	234.0		
27.0	198.8	72.0	235.1		
28.0	199.5	73.0	236.4		
29.0	200.1	74.0	237.6		
30.0	200.9	75.0	238.7		
31.0	201.8	76.0	240.0		
32.0	202.8	77.0	241.2		
33.0	203.7	78.0	242.2		
34.0	204.7	79.0	243.3		
35.0	205.4	80.0	244.4		
36.0	206.1	81.0	245.5		
37.0	206.8	82.0	246.5		
38.0	207.6	83.0	247.5		
39.0	208.4	84.0	248.7		
40.0	209.1	85.0	249.6		
41.0	209.8	86.0	250.3		
42.0	210.7	87.0	251.0		
43.0	211.4	88.0	251.9		
44.0	211.9	89.0	253.2		

Recovery: 100.0
Analysis Area: 1.5338e+04
Sample Amt: 1.0000
R.Time Date: 6/23/2000
R.Factor Date:

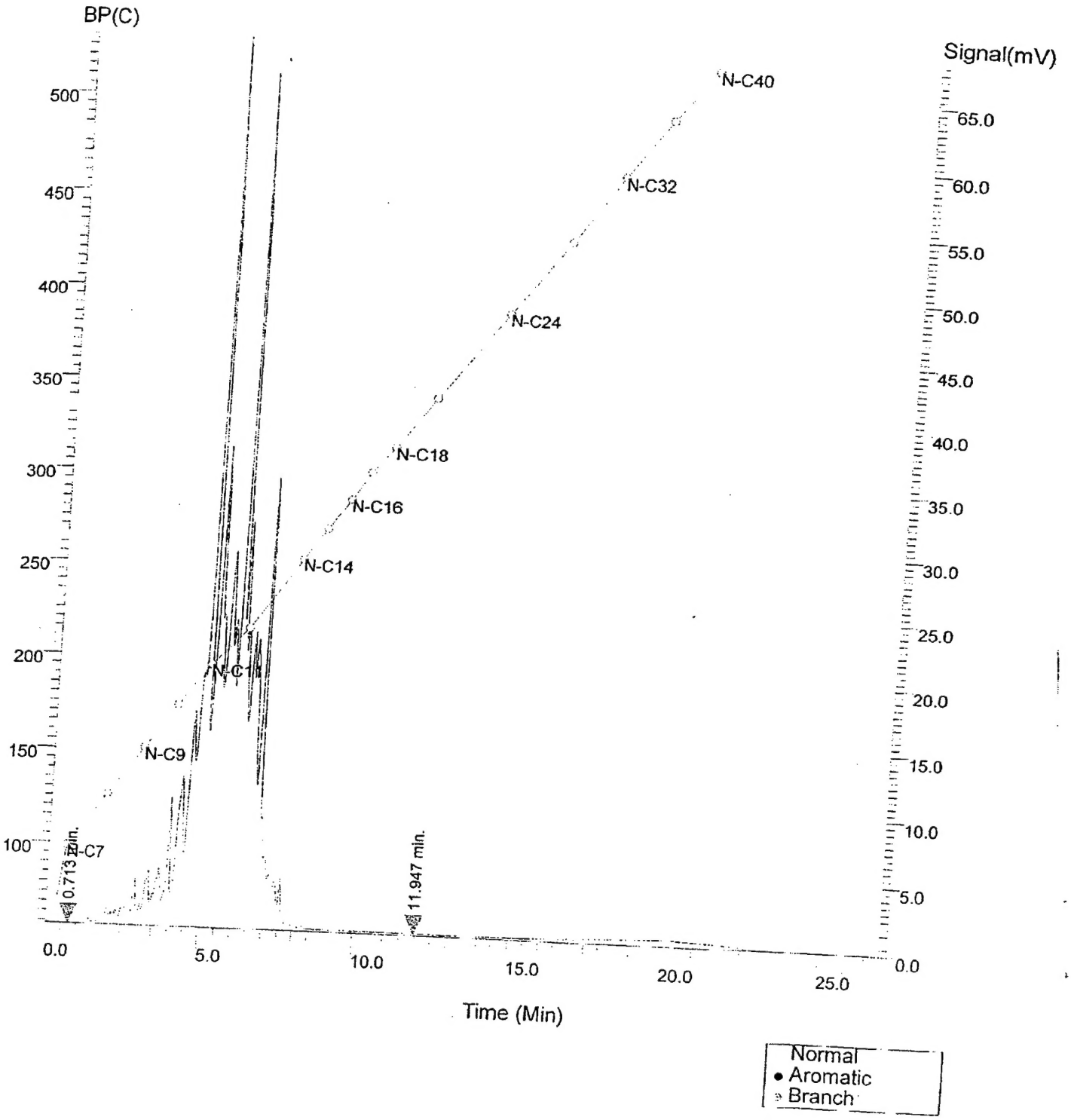
Start Time: 0.01 min.
Start Signal: 0.000 mV
Solvent Amt: 1.0000
R.Time File: C:\Star\Module16\D2887ST20C J2000 1M1001.CDF
R.Factor File:
Blank File:

End Time: 11.02 min.
End Signal: 0.000 mV

File: C:\Star\Module16\JL1700 AL263111.CDF
Sample: JL1700 AL26311
Parameter: D2887

JUL 17, 2000 - 14:06:17
Operator:

Calibration Curve
ASTM D2887



File: C:\Star\Module16\JL1700 AL263111.CDF
Sample: JL1700 AL26311
Parameter: D2887

JUL 17, 2000 - 14:06:17
Operator:

Boiling Point Table

ASTM D2887

%Off	BP(C)	%Off	BP(C)	%Off	BP(C)
IBP	133.4	45.0	204.4	90.0	230.7
1.0	140.9	46.0	205.0	91.0	231.2
2.0	151.1	47.0	205.4	92.0	231.6
3.0	158.8	48.0	205.9	93.0	232.2
4.0	165.0	49.0	206.3	94.0	233.5
5.0	170.3	50.0	206.7	95.0	235.5
6.0	173.4	51.0	207.2	96.0	238.3
7.0	177.0	52.0	207.7	97.0	242.2
8.0	179.3	53.0	208.3	98.0	246.8
9.0	180.7	54.0	208.8	99.0	256.2
10.0	182.2	55.0	209.3	FBP	289.6
11.0	184.6	56.0	209.9		
12.0	186.1	57.0	210.4		
13.0	187.0	58.0	211.1		
14.0	188.0	59.0	211.5		
15.0	189.1	60.0	211.8		
16.0	190.2	61.0	212.0		
17.0	191.1	62.0	212.2		
18.0	191.8	63.0	212.4		
19.0	192.6	64.0	212.6		
20.0	193.4	65.0	212.8		
21.0	194.1	66.0	213.0		
22.0	194.6	67.0	213.4		
23.0	194.9	68.0	213.9		
24.0	195.2	69.0	214.4		
25.0	195.4	70.0	214.8		
26.0	195.6	71.0	215.2		
27.0	195.8	72.0	215.6		
28.0	196.1	73.0	216.2		
29.0	196.3	74.0	216.9		
30.0	196.7	75.0	217.6		
31.0	197.4	76.0	218.4		
32.0	198.1	77.0	219.4		
33.0	198.7	78.0	220.4		
34.0	199.2	79.0	221.2		
35.0	199.5	80.0	221.9		
36.0	199.8	81.0	222.6		
37.0	200.2	82.0	223.5		
38.0	200.6	83.0	224.2		
39.0	201.0	84.0	224.9		
40.0	201.5	85.0	225.7		
41.0	202.0	86.0	226.5		
42.0	202.5	87.0	227.4		
43.0	203.1	88.0	228.5		
44.0	203.7	89.0	229.9		

Recovery: 100.0
Analysis Area: 9.9226e+03
Sample Amt: 1.0000
R.Time Date: 6/23/2000
R.Factor Date:

Start Time: 0.71 min.
Start Signal: 0.000 mV
Solvent Amt: 1.0000
R.Time File: C:\Star\Module16\D2887ST20C J2000 1M1001.CDF
R.Factor File:
Blank File:

End Time: 11.95 min.
End Signal: 0.106 mV

AFIERA/DOBP (STINFO)
2513 KENNEDY CIRCLE
BROOKS AFB TX 78235-5123

OFFICIAL BUSINESS